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APPLICATION NUMBER: 60/439,254

FILING DATE: January 10, 2003

RELATED PCT APPLICATION NUMBER: PCT/US04/00556

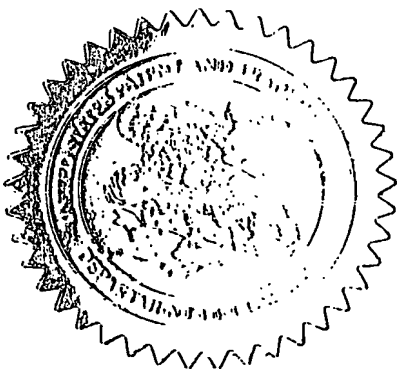
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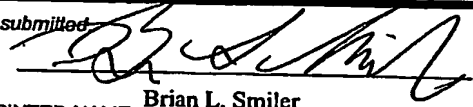
# PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. EV049330869US

U.S. PTO  
60/439254

INVENTOR(S)					
Given Name (first and middle (if any))		Family Name or Surname		Residence (City and either State or Foreign Country)	
Beverly Maria (Stentz) Songsdh		Piatt Rigling Chongsiriwantana			
<input checked="" type="checkbox"/> Additional Inventors are being named on the <u>1</u> separately numbered sheets attached hereto					
TITLE OF THE INVENTION (500 characters max)					
ELECTROHYDRODYNAMIC NOZZLE					
Direct all correspondence to: CORRESPONDENCE ADDRESS					
<input checked="" type="checkbox"/> Customer Number		23368			
OR		Type Customer Number here			
<input type="checkbox"/> Firm or Individual Name		23368 PATENT TRADEMARK OFFICE			
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ENCLOSED APPLICATION PARTS (check all that apply)					
<input checked="" type="checkbox"/> Specification		Number of Pages		10	
<input checked="" type="checkbox"/> Drawing(s)		Number of Sheets		5	
<input checked="" type="checkbox"/> Application Data Sheet. See 37 CFR 1.76		<input type="checkbox"/> CD(s), Number			
		<input type="checkbox"/> Other (specify)			
METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT					
<input checked="" type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27.				FILING FEE AMOUNT (\$)	
<input checked="" type="checkbox"/> A check or money order is enclosed to cover the filing fees				80.00	
<input type="checkbox"/> The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number:					
<input type="checkbox"/> Payment by credit card. Form PTO-2038 is attached.					
The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.					
<input checked="" type="checkbox"/> No.					
<input type="checkbox"/> Yes, the name of the U.S. Government agency and the Government contract number are:					

Respectfully submitted  
SIGNATURE   
TYPED or PRINTED NAME Brian L. Smiler  
TELEPHONE (937) 223-2050

Date 01/10/03

REGISTRATION NO. 46,458  
(if appropriate)  
Docket Number: BAT 0076 MA

## USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

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**PROVISIONAL APPLICATION COVER SHEET**  
*Additional Page*

PTO/SB/16 (10-01)  
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Docket Number			BAT 0076 MA
INVENTOR(S)/APPLICANT(S)			
Given Name (first and middle (if any))	Family or Surname	Residence (City and either State or Foreign Country)	
Jim	Dvorsky		

Number 2 of 2

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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE**FEE TRANSMITTAL  
for FY 2003**

Effective 01/01/2003. Patent fees are subject to annual revision.

☒ Applicant claims small entity status. See 37 CFR 1.27**TOTAL AMOUNT OF PAYMENT** (\$ 80.00)**Complete if Known**

Application Number	
Filing Date	January 10, 2003
First Named Inventor	Beverly Platt
Examiner Name	
Art Unit	
Attorney Docket No.	BAT 0076 MA

**METHOD OF PAYMENT (check all that apply)**☒ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None☐ Deposit Account:

Deposit Account Number	
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The Commissioner is authorized to: (check all that apply)

- ☐ Charge fee(s) indicated below ☐ Credit any overpayments
- ☐ Charge any additional fee(s) during the pendency of this application
- ☐ Charge fee(s) indicated below, except for the filing fee to the above-identified deposit account.

**FEE CALCULATION****1. BASIC FILING FEE**

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1001	750	2001	375	Utility filing fee	
1002	330	2002	165	Design filing fee	
1003	520	2003	260	Plant filing fee	
1004	750	2004	375	Reissue filing fee	
1005	160	2005	80	Provisional filing fee	80.00
<b>SUBTOTAL (1)</b>					<b>(\$ 80.00)</b>

**2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE**

Total Claims		-20** =		X		Fee Paid
Independent Claims		-3** =		X		
Multiple Dependent						

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1202	18	2202	9	Claims in excess of 20	
1201	84	2201	42	Independent claims in excess of 3	
1203	280	2203	140	Multiple dependent claim, if not paid	
1204	84	2204	42	** Reissue independent claims over original patent	
1205	18	2205	9	** Reissue claims in excess of 20 and over original patent	
<b>SUBTOTAL (2)</b>					<b>(\$ 0.00)</b>

\*\*or number previously paid, if greater; For Reissues, see above

**FEE CALCULATION (continued)****3. ADDITIONAL FEES**

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for ex parte reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	410	2252	205	Extension for reply within second month	
1253	930	2253	465	Extension for reply within third month	
1254	1,450	2254	725	Extension for reply within fourth month	
1255	1,970	2255	985	Extension for reply within fifth month	
1401	320	2401	160	Notice of Appeal	
1402	320	2402	160	Filing a brief in support of an appeal	
1403	280	2403	140	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive - unavoidable	
1453	1,300	2453	650	Petition to revive - unintentional	
1501	1,300	2501	650	Utility issue fee (or reissue)	
1502	470	2502	235	Design issue fee	
1503	630	2503	315	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17(q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	750	2809	375	Filing a submission after final rejection (37 CFR 1.129(a))	
1810	750	2810	375	For each additional invention to be examined (37 CFR 1.129(b))	
1801	750	2801	375	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	
Other fee (specify)					
*Reduced by Basic Filing Fee Paid					
<b>SUBTOTAL (3)</b>					<b>(\$ 0.00)</b>

**SUBMITTED BY**

Name (Print/Type)	Brian L. Smiler	Registration No. (Attorney/Agent)	46,458	Telephone	(937) 223-2050
Signature		Date	January 10, 2003		

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**Initial Information Data Sheet****Inventor Information**

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**Application Information**

**Title Line One::** ELECTROHYDRODYNAMIC NOZZLE  
**Total Drawing Sheets::** 5  
**Formal Drawings?::** Yes  
**Application Type::** Provisional  
**Docket Number::** BAT 0076 MA

**Representative Information**

<b>Registration Number One::</b>	<b>26,397</b>
<b>Registration Number Two::</b>	<b>27,262</b>
<b>Registration Number Three::</b>	<b>29,001</b>
<b>Registration Number Four::</b>	<b>39,564</b>
<b>Registration Number Five::</b>	<b>38,769</b>
<b>Registration Number Six::</b>	<b>33,758</b>
<b>Registration Number Seven::</b>	<b>42,695</b>
<b>Registration Number Eight::</b>	<b>46,867</b>
<b>Registration Number Nine::</b>	<b>46,506</b>
<b>Registration Number Ten::</b>	<b>46,458</b>
<b>Registration Number Eleven::</b>	<b>48,624</b>
<b>Registration Number Twelve::</b>	<b>52,364</b>

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of

Applicants : Piatt et al.

Title : ELECTROHYDRODYNAMIC NOZZLE

Docket No. : BAT 0076 MA

**BOX PROVISIONAL PATENT APPLICATION**

Assistant Commissioner for Patents

Washington, DC 20231

Sir:

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service under 37 CFR 1.10 on the date indicated above and is  
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Melody J. Tolliver  
Legal Secretary

BLS/kec

## ELECTROHYDRODYNAMIC NOZZLE

### BACKGROUND OF THE INVENTION

[0001] The present invention relates to the production of an aerosol by means of electrohydrodynamics, and a device for the application of the electrically charged particles of material so produced. More particularly, the invention relates to the application of chemical agents such as, for example, herbicides, fungicides, insecticides, acaricides, miticides, molluscicides, nematocides, rodenticides, plant-desiccants, plant-growth regulators, etc. (pesticides in general), to a target.

[0002] The application of liquid formulations to crops, turfs, trees, and other plants as well as spraying of pesticides in and around the home using sprayers has been practiced for many years. More specifically, electrostatic sprayers have been developed to atomize pesticides for application on a target. For example, Coffee, U.S. Patent No. 4,356,528, teaches an electrostatic sprayer to be used for ultra-low volume ("ULV") spraying of pesticides. The sprayer includes multiple metal capillary tubes as spray nozzles, an insulating cover, and a field-intensifying ring electrode. Other examples of electrostatic sprayers include U.S. Patent Nos. 4,376,514; 4,467,961; 4,470,550; 4,735,364; 4,476,515; 4,580,721; 4,629,164; and 6,105,571.

[0003] The present inventors have recognized a need for improvements in electrohydrodynamic sprayer design.

### SUMMARY OF THE INVENTION

[0004] The present invention meets the above-mentioned need by providing a nozzle for an electrohydrodynamic spray device that produces a charged aerosol. Although the present invention is not limited to specific advantages or functionality, it is noted that the nozzle creates a very focused and directed spray. Accordingly, when used to spray a form of targeted vegetation such as, for example, a weed, with a liquid formulation (for example, a pesticide), the particles effectively cover the stems and

underside of plant leaves due to the fact that the aerosol possesses an electrical charge.

[0005] In accordance with one embodiment of the present invention, the nozzle comprises a manifold having one fluid entrance and one or more discrete fluid exits or fluid spray sites. The fluid spray sites can be arranged in a linear array and are in communication with a charged electrode.

[0006] In accordance with another embodiment of the present invention, the nozzle can comprise a manifold having one fluid entrance and one or more discrete fluid exits or fluid spray sites with equidistant passages in fluid communication with the fluid spray sites. Accordingly, fluid traveling within the manifold covers an equal distance from the fluid entrance to any of the one or more fluid spray sites. The fluid spray sites can be arranged in a linear array and are in communication with a charged electrode. However, the manifold of the instant embodiment having equidistant passages allows for fluid spray site arrays of different geometric shapes and orientations, while still maintaining equal flow of a liquid formulation to each discrete fluid spray site. The instant embodiment allows for a very wide range of flow rates since flow restrictions for low flow rates can be designed into the passages, if required, and thus allows for scale up of a single nozzle to any number of nozzles.

[0007] In accordance with still another embodiment of the present invention, the nozzle comprises a spray shaping mechanism that defines directing electrodes positioned equidistant at opposite ends of the one or more fluid spray sites, which fluid spray sites can be arranged in a linear array. The directing electrodes are charged at the same polarity and voltage as the fluid spray sites and are effective in improving the uniformity of the linear nozzle array electrohydrodynamic spray device. No fluid is passed through the directing electrodes.

[0008] In accordance with yet another embodiment of the present invention, the nozzle comprises a spray shaping mechanism that optionally defines parallel counter

electrodes. The counter electrodes comprise thin parallel rods that are arranged in parallel with and straddle the one or more fluid spray sites, which fluid spray sites can be arranged in a linear array. The combination of vertical and horizontal positioning of the parallel counter electrodes in relation to the array of fluid spray sites effectively provides for directional spraying and provides for variations in the aerosol spray shape.

[0009] In accordance with still yet another embodiment of the present invention, the nozzle can optionally comprise a manifold having one fluid entrance and one or more discrete fluid exits or fluid spray sites with equidistant passages in fluid communication with the fluid spray sites, which fluid spray sites can be arranged in a linear array, and a spray shaping mechanism that defines both directing electrodes positioned equidistant at opposite ends of the fluid spray sites, and parallel counter electrodes that comprise thin parallel rods that are arranged in parallel with and straddle the one or more fluid spray sites. The directing electrodes are charged at the same polarity and voltage as the fluid spray sites and the counter electrodes form a stable electric field at the fluid spray sites which can propel the spray forward or shape the spray so that it comes in contact with a particular target. Accordingly, the nozzle of this embodiment of the present invention can be configured to produce a charged aerosol to a complex shaped target.

[0010] These and other features and advantages of the invention will be more fully understood from the following detailed description of the invention taken together with the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The following detailed description of the embodiments of the present invention can be best understood when read in conjunction with the following drawings, where like structure is indicated with like reference numerals and in which:

[0012] Fig. 1 is a schematic block diagram showing some of the different components that make up an electrohydrodynamic spray device comprising a nozzle in accordance with one embodiment of the present invention;

[0013] Fig. 2 shows a front plan view of a nozzle for an electrohydrodynamic spray device in accordance with the present invention;

[0014] Fig. 3 shows a side plan view of a nozzle for an electrohydrodynamic spray device in accordance with the present invention;

[0015] Fig. 4 shows a top plan view of a nozzle for an electrohydrodynamic spray device in accordance with the present invention; and

[0016] Fig. 5 is a schematic illustration of a manifold for an electrohydrodynamic spray device in accordance with the present invention.

[0017] Skilled artisans appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions of some of the elements in the figures may be exaggerated relative to other elements to help improve understanding of embodiment(s) of the present invention.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

[0018] Referring initially to Fig. 1, a schematic block diagram of an electrohydrodynamic spray device 1 is illustrated. In accordance with one exemplary embodiment of the present invention, the device 1 can comprise the following components: a control panel 2, a power source 3, a pumping mechanism 4, a high voltage power supply 5, a fluid container/cartridge 6, a nozzle 8, and a spray head 10. Reference is made to the commonly assigned U.S. Provisional Patent Applications entitled "SPRAY HEAD FOR ELECTROHYDRODYNAMIC SPRAY DEVICE" (Attorney Docket No. BAT 0077 MA), "FLUID CONTAINER FOR ELECTROHYDRODYNAMIC SPRAY DEVICE" (Attorney Docket No. BAT 0078 MA), and

"ELECTROHYDRODYNAMIC SPRAYER SYSTEM" (Attorney Docket No. BAT 0079 MA), which further describe the components making up the device 1, the disclosures of which are incorporated herein by reference. The components can be connected by a plurality of electrical and mechanical interfaces. The device 1 can be configured to be portable and effectively provides a charged aerosol of a liquid formulation by means of electrohydrodynamics.

[0019] Referring now to Figs. 2-5, in accordance with another embodiment of the present invention, the nozzle 8 can comprise a manifold 12 having one fluid entrance 13 and one or more discrete fluid exits or fluid spray sites 15. The fluid spray sites 15 are preferably arranged in a linear array. However, fluid spray sites 15 of different configurations are also contemplated and are intended as being within the scope of the present application such as, for example, a circular array of fluid spray sites 15.

[0020] The nozzle 8 that is defined by the electrohydrodynamic spray device 1 of the present invention is configured to create a charged aerosol of a liquid formulation by causing the liquid to flow over a region of high electric field strength. The region of high electric field strength can be provided by a charged electrode, which is in communication with the fluid spray sites 15, and which provides the liquid formulation with a net electric charge. The charge tends to remain on the surface of the liquid such that, as the liquid exits the nozzle 8, the repelling force of the surface charge balances against the surface tension of the liquid, forming a Taylor cone. The electrical force exerted on the liquid surface overcomes the surface tension at the tip of the cone, generating a thin jet of liquid. This jet breaks into droplets of more or less uniform size, which collectively form a cloud of charged liquid particles.

[0021] The nozzle 8 that is defined by the present application is effective in forming a charged aerosol of numerous formulations at a controlled flow rate and predictable spray pattern. The liquid formulation can have a wide range of physical properties and still remain sprayable such as, for example, a resistivity between about 100 and about 5,000,000 Ohm-m and a viscosity between about 0.8 and about 590 cP.

Moreover, the liquid formulation can contain an active ingredient, such as a pesticidal compound.

[0022] In accordance with still another embodiment of the present invention, the nozzle 8 can comprise a manifold 12 having one fluid entrance 13 and one or more discrete fluid exits or fluid spray sites 15 with equidistant passages 14 in fluid communication with the fluid spray sites 15 (see Fig. 5). Accordingly, fluid traveling within the manifold 12 covers an equal distance from the fluid entrance 13 to any of the one or more fluid spray sites 15. The fluid spray sites 15 can be arranged in a linear array and are in communication with a charged electrode. However, the manifold 12 of the instant embodiment having equidistant passages 14 allows for fluid spray site arrays of different geometric shapes and orientations, including a portable device, while still maintaining equal flow of a liquid formulation to each discrete fluid spray site 15. This aspect of the present invention enables steady electrohydrodynamic spraying of a liquid formulation as certain applications requiring a delivered volume or rate of a liquid formulation can only be obtained from multiple fluid spray sites 15. Moreover, the instant embodiment allows for a very wide range of flow rates since flow restrictions for low flow rates can be designed into the passages 14, if required, and thus allows for scale up of a single nozzle 8 to any number of nozzles 8. Multiple nozzles 8 can be employed for spraying multiple fluid formulations from a single electrohydrodynamic spray device 1. The passages 14 can be configured so that they are deep enough to allow a more viscous fluid formulation to be sprayed by maintaining backpressure with a standard pumping device.

[0023] The manifold 12 of the instant embodiment can be configured so that there are two or more discrete fluid exits or fluid spray sites 15 for each final passage 14. The number of exits per fluid exit trough can be designed to accommodate the requisite number of exits. This allows the fluid formulation to be distributed at an even flow rate to discrete exits, which provides stability of Taylor cone formation and enables the formation of a more controlled and predictable aerosol.

[0024] In accordance with yet another embodiment of the present invention, the nozzle 8 comprises a spray shaping mechanism that defines directing electrodes 20 positioned equidistant at opposite ends of the one or more fluid spray sites 15, which fluid spray sites 15 can be arranged in a linear array. The directing electrodes 20 are charged at the same polarity and voltage as the fluid spray sites 15. This feature provides certain manufacturing advantages do to the fact that the same power supply can be used for both the directing electrodes 20 and the fluid spray sites 15. However, unlike the fluid spray sites 15 no fluid is passed through the directing electrodes 20. The directing electrodes 20 stabilize the Taylor cones and fluid spray sites 15 at the ends of the linear array and keep the aerosol directed forward rather than to the sides. Accordingly, the directing electrodes 20 are effective in producing a charged aerosol that is more uniform from the ends to the center of the linear array of fluid spray sites 15.

[0025] In accordance with still yet another embodiment of the present invention, the nozzle 8 comprises a spray shaping mechanism that defines parallel counter electrodes 30. The parallel counter electrodes 30 can be employed in localizing the electric field that is produced by the nozzle 8 for spraying a charged aerosol. Depending on the position of the counter electrodes 30 relative to the one or more fluid spray sites 15, the counter electrodes 30 can effectively boost the velocity of the electrohydrodynamic spray forward, as well as shape or split the spray toward a desired target. Accordingly, the counter electrodes 30 provide a shaping and/or propelling effect for the aerosol. The counter electrodes 30 further allow for both high and low nozzle density in a linear array of fluid spray sites 15. This feature of the instant embodiment presents a more uniform field to each fluid spray site 15, independent of the spray sites position within the nozzle 8. Moreover, the parallel counter electrodes 30 when combined with the linear array of fluid spray sites 15 provide more stable electrohydrodynamic spray and Taylor cone formation of a liquid formulation, independent of the distance between the nozzle 8 and the grounded target.

[0026] The counter electrodes 30 comprise thin parallel rods that are arranged in parallel with and straddle the one or more fluid spray sites 15, which fluid spray sites 15 can be arranged in a linear array. The combination of vertical and horizontal positioning of the parallel counter electrodes 30 in relation to the array of fluid spray sites 15 effectively provides for directional spraying and give variations in the aerosol spray shape. The distance vertically 40 (see Fig. 2) and horizontally 50 (see Figs. 3 and 4) from the counter electrodes 30 to the one or more fluid spray sites 15 assists in shaping the Taylor cone formation, thus allowing a propelling effect when positioned in front or out from the tip of the nozzle 8, and a splitting of the spray when the counter electrodes 30 or parallel rods are placed closer to the tip of the nozzle 8. Accordingly, the counter electrodes 30 can be employed to shape the charged aerosol so that it reaches and covers a specified target.

[0027] In accordance with still yet another embodiment of the present invention, the nozzle 8 can optionally comprise a manifold 12 having one fluid entrance 13 and one or more discrete fluid exits or fluid spray sites 15 with equidistant passages 14 in fluid communication with the fluid spray sites 15, which fluid spray sites 15 can be arranged in a linear array, and a spray shaping mechanism that defines both directing electrodes 20 positioned equidistant at opposite ends of the fluid spray sites 15, and parallel counter electrodes 30 that comprise thin parallel rods that are arranged in parallel with and straddle the one or more fluid spray sites 15. The directing electrodes 20 are charged at the same polarity and voltage as the fluid spray sites 15, and the counter electrodes 30 form a stable electric field at the fluid spray sites 15 which can propel the spray forward or shape the spray so that it comes in contact with a particular target. Each of the elements making up this nozzle 8 are described with particularity herein. The instant embodiment is a combination of all of these elements in a single nozzle 8 for an electrohydrodynamic spray device 1. Accordingly, the nozzle 8 of this embodiment of the present invention can be configured to produce a charged aerosol that is designed to come in contact with a complex or flat shaped target.

[0028] While the invention has been described by reference to certain preferred embodiments, it should be understood that numerous changes could be made within the spirit and scope of the inventive concepts described. This includes modification to the embodiment shown in sketches from hand-held devices to other configurations which include but are not limited to boomed devices pulled behind tractors, stationary-frames used to place a plant in to treat, and devices integrally installed in green-houses/glass-houses devices. Accordingly, it is intended that the invention not be limited to the disclosed embodiments, but that it have the full scope permitted by the language of the following claims.

[0029] What is claimed is:

CLAIMS

1. A nozzle for an electrohydrodynamic spray device including one or more of the novel features described in the above specification and drawings.
2. A nozzle for an electrohydrodynamic spray device substantially as described in the above specification and in the accompanying drawings.

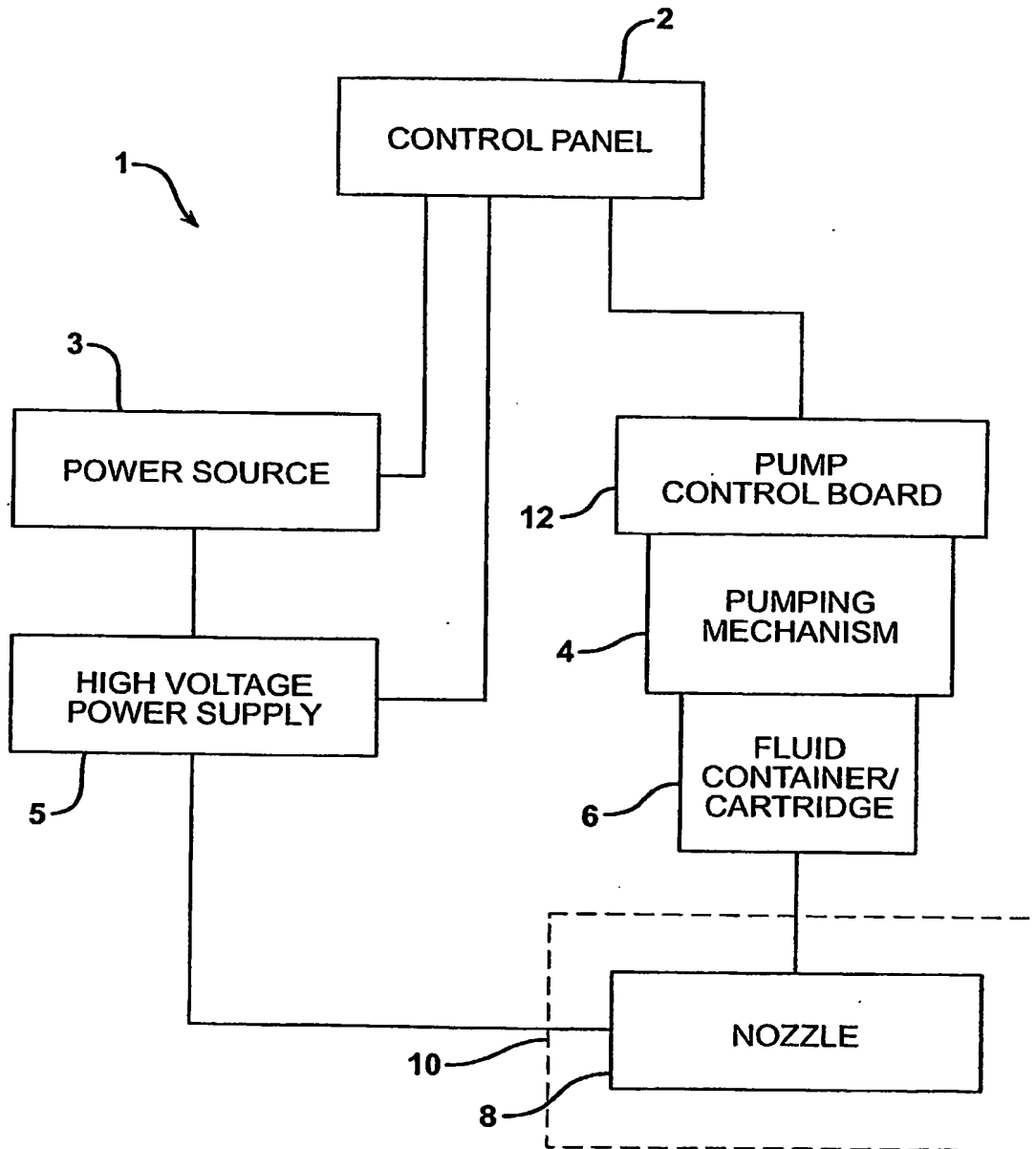


FIG. 1

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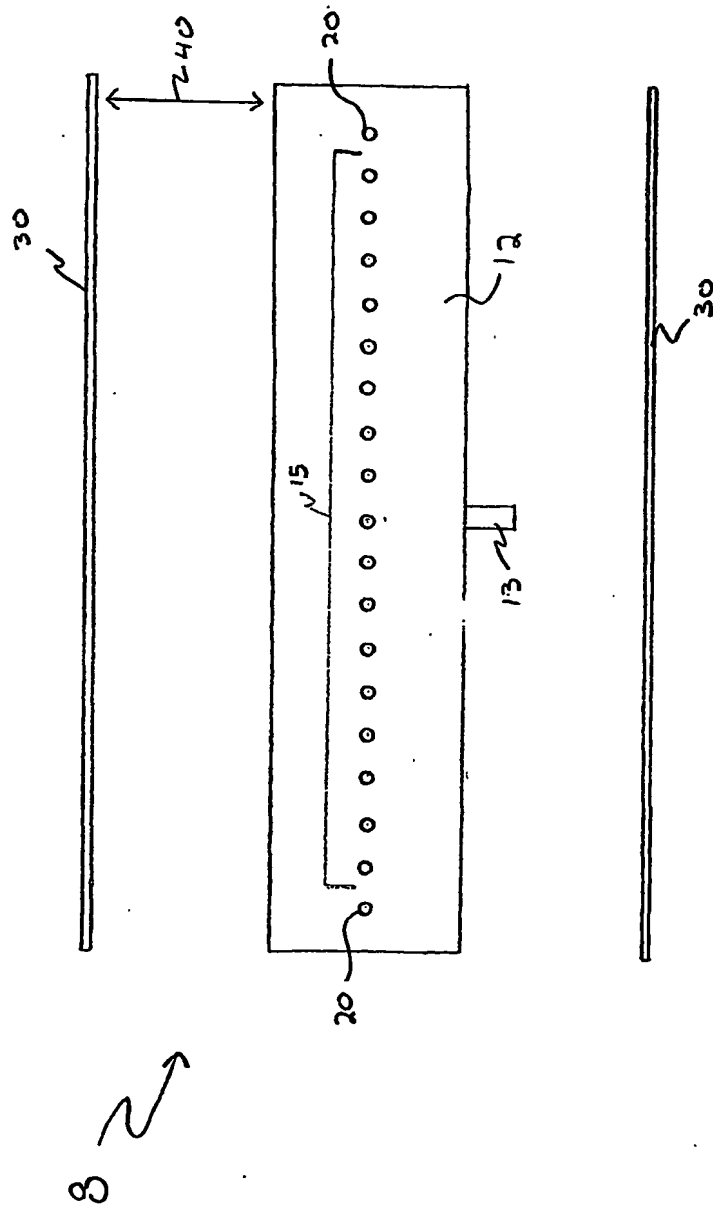


Fig. 2

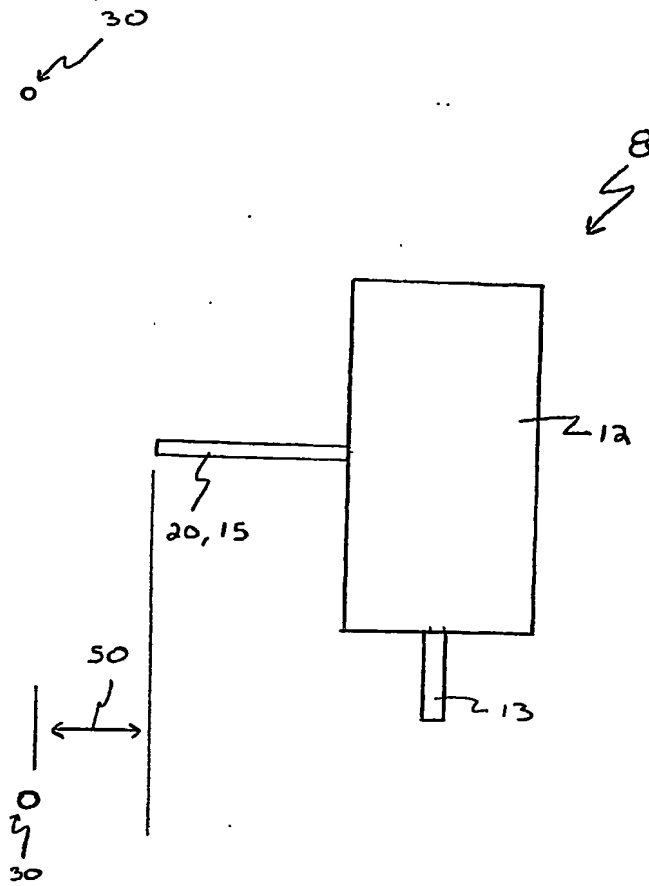


Fig. 3

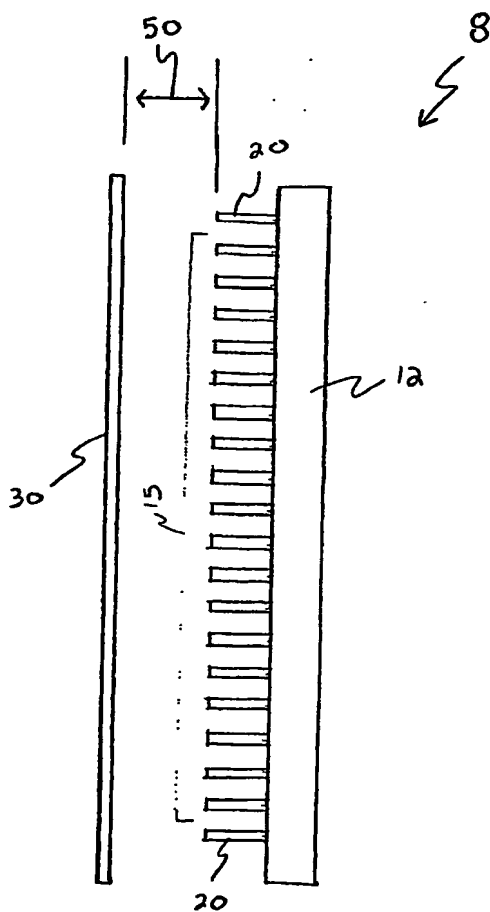


Fig. 4

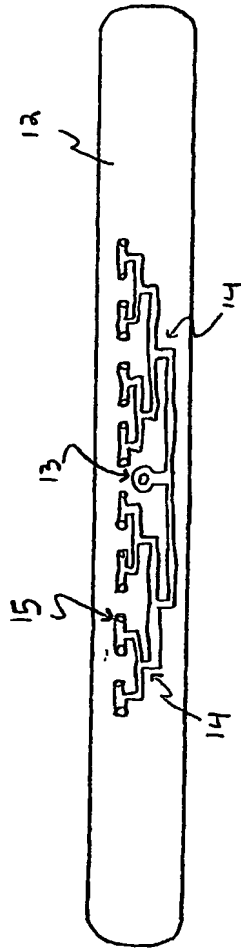


Fig. 5